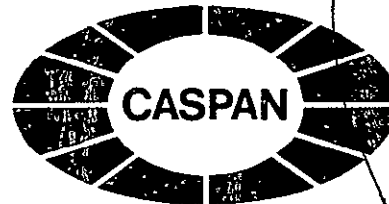


Final Report

on

The Feasibility of Establishing Operational  
Water Hyacinth-Based Systems at the  
Treatment Facilities of Existing Cities



(NASA-CR-155511) THE FEASIBILITY OF ESTABLISHING OPERATIONAL WATER  
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CASPAN  
Engineers and Constructors  
Houston, Texas

November, 1977

N78-14947

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by

Caspan Corporation  
411 Durham Drive  
Houston, Texas

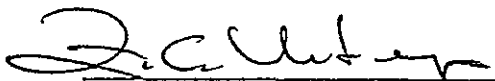
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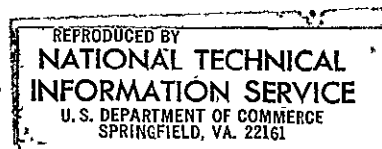
Under

Contract NASW-3091, SB6338(a)77C-217

Approved by:

  
F. C. Urteaga, Project Manager

Nelson Milder, Manager of Environ-  
mental Systems



November, 1977

## FOREWORD

This report was prepared under contract NASW-3091, SB6338(a)77c-217, with NASA Headquarters, Washington, D.C.

The work under this contract was performed by Caspan Corporation with Frank Urteaga Project Manager, and two consultants, Dr. Richard Allison and Dr. Monica Jorque, both of the University of Houston at Clear Lake City.

In the process of performing this study, cities in South Florida and South Texas were contacted to ascertain their positions in reference to a water hyacinth-based wastewater treatment system at their existing or future facilities.

Input and conclusions from these contacts are presented in the following report.

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## 1.0 BACKGROUND

### 1.1 Contract Award

Caspan Corporation was awarded contract NASW3091, SB 6338(a)77C-217, to study the feasibility of establishing operational water hyacinth-based systems at the treatment facilities of existing cities, effective June, 1977.

### 1.2 Statement of Work

Contract NASW-3091 was awarded to conduct a survey of the wastewater treatment facilities of three (3) communities in the South Florida area and two (2) communities in the South Texas area with populations of 20,000 persons or less to provide NASA Headquarters with the following information:

- 1.2.1 Description and performance characteristics of existing facilities and population customers served by those facilities; for example, domestic and industrial customers;
- 1.2.2 Facility upgrading requirements needed to meet current and future EPA and State standards, including performance requirements, schedules, cost factors, or various alternatives approached under consideration;
- 1.2.3 An evaluation of the adaptability of existing systems to water hyacinth utilization, including area compatibility to harvested plant disposal methods such as compost, fertilizer, methane gas generation, animal feed, etc., and an estimate of cost factors, such as capital investment, operational costs, etc., required to implement the water hyacinth treatment systems; and
- 1.2.4 An evaluation of the willingness of community authorities to participate in the above-mentioned program, including an estimate of the level of community support available to the proposed project.

### 1.3 Nature of the Problem

#### 1.3.1 Biological Effect of Water Hyacinths

The water hyacinth, Eichornia crassipes, has been classified as a noxious weed by the Texas Fish and Wildlife Commission because of its ability to multiply at such a rate as to completely



### 1.3.1 (continued)

cover a water surface in a matter of days. The rate of growth is logarithmic and the reported area doubling times have ranged from 6 to 12 days. The presence of a hyacinth cover on a body of water effectively impedes navigation and interferes with other normal water uses.

As efforts to control or eradicate these plants increase, efforts to find a beneficial use for them also receive considerable attention. One of the most promising of these uses has been found in the field of wastewater treatment, specifically in the upgrading of stabilization pond effluent.

### 1.3.2 Stabilization Ponds

A stabilization pond is a secondary wastewater treatment system in which an artificial pond is used to receive effluent from a primary facility. Ponds have historically been used for small communities because of the considerable amount of surface area required for effective use. The water purification process involves the decomposition of soluble materials by the action of bacteria, algae and zooplankton from pollutants present in raw effluent.

Stabilization ponds require little operator attention and do not require a centralization of facilities. The performance of these ponds depends on loading rates, retention time and season of year. Even under optimum operating conditions, stabilization pond effluents have in the past failed to meet the 85% removal efficiency rate required by the Environmental Protection Agency as of July 1, 1977.

### 1.3.3 Effluent Quality Requirements

More stringent requirements are due to be imposed by July 1, 1983. Federal regulations at that time will require advanced treatment of "best available treatment technology." State requirements are at least as stringent as Federal requirements as far as specific state effluent regulations are concerned. Texas and Florida's regulations will be examined in more detail below.

#### 1.3.3.1 Florida

Florida presently requires 90% BOD<sub>5</sub> and suspended solids removal from most plants, and in some cases has required advanced wastewater treatment, as defined in table I:

#### 1.3.3.1 (continued)

BOD <sub>5</sub> .....	5 mg/l
Suspended Solids.....	5 mg/l
Total Nitrogen.....	3 mg/l
Total Phosphorus.....	1 mg/l

It is expected that Florida will enforce the above by 1983.

#### 1.3.3.2 Texas

Texas' effluent limits are based upon waste load allocation, which depends on the receiving stream's assimilative capacity. The 30-day BOD<sub>5</sub>, suspended solids, and nutrient limitations for Texas are as defined in table II:

Level	0	I	II	III	IV	IIN	IIIN	IVN	IIIP	IVP
BOD <sub>5</sub>	30	20	10	5	5	10	5	5	5	5
Sus. Solids	30	20	15	10	5	15	10	5	10	5
Total N	--	--	--	--	--	5	5	3	--	--
Total P	--	--	--	--	--	--	--	--	2	1

It should be noted from the above that there are no concurrent nitrogen and phosphorus limits being considered. Therefore, the thrust of a treatment system could be either toward nitrogen or phosphorus removal, wherever the greatest need may be.

#### 1.3.4 Current Treatment Methods

Conventional tertiary wastewater treatment available to meet the above requirements for Florida and Texas are typically capital and labor intensive. They include, for example, the following systems:

1.3.4.1 Filtration for suspended solids and BOD<sub>5</sub> removal;

1.3.4.2 Carbon absorption for suspended solids and BOD<sub>5</sub> removal;

#### 1.3.4 (continued)

1.3.4.3 Lime clarificaition for phosphorus and suspended solids removal;

1.3.4.4 Ammonia stripping for nitrogen removal;

1.3.4.5 Nitritification/denitritification

1.3.4.6 Breakpoint chlorination for nitrogen removal; and/or

1.3.4.7 Ion exchange for nitrogen and phosphorus removal.

A typical system having an existing secondary facility could consist of lime clarification followed by filtration. It is with the above systems that the envisioned water hyacinth-based treatment system is expected to compete.

#### 1.3.5 Previous Research

The ability of water hyacinths to remove nutrients, BOD<sub>5</sub>, and other pollutants from wastewater has been reported by numerous investigators. In some cases, the potential for achieving tertiary treatment levels has been aptly demonstrated. The most recent and notable of these studies were performed at the National Space Technology Laboratory in Bay St. Louis, Mississippi; the Texas Department of Health Resources in Austin, Texas; and the University of Florida at Gainesville, Florida.

##### 1.3.5.1 National Space Technology Laboratory Studies

Studies performed by the National Space Technology Laboratory in Bay St. Louis, Mississippi, show that water hyacinths are effective in upgrading municipal wastewater treatment systems.

In two (2) experiments involving wastewater from the cities of Bay St. Louis and Orange Grove, Mississippi, pond performance improvement was marked. Under conditions of these studies, BOD<sub>5</sub>, suspended solids, and nitrogen levels were consistently below the required levels after introduction of water hyacinths to the ponds. Some of the results of these experiments are tabulated in table III:

#### 1.3.5.1 (continued)

Parameter	Requirement	Bay St. Louis Ann. Avg.	Orange Grove Ann. Avg.      July-Sept.	
Sus. Solids	30 mg/l	16 mg/l	14 mg/l	9.3 mg/l
BOD <sub>5</sub>	15 mg/l	15 mg/l	less than 15 mg/l	6.3 mg/l
Total N	6 mg/l	-----	3.02 mg/l	1.2 mg/l
Total P	-----	-----	-----	4.3 mg/l
Retention Time-----		12 days	-----	21 days
Pond Surface Area----		6 acres	-----	0.7 acres

#### 1.3.5.2 Texas Department of Health Resources Studies

Results of studies conducted by the Texas Department of Health Resources also indicate that water hyacinths are capable of attaining effluent quality standards higher than those currently required for BOD<sub>5</sub> and suspended solids. These results are summarized in table IV.

Parameter	Rqmts.	Mthly Avg. Range	Sept. - Jan.
Sus. Solids	30 mg/l	7.0-7.5 mg/l	8.6 mg/l
BOD <sub>5</sub>	30 mg/l	5.2-5.7 mg/l	6.4 mg/l
Total N	-----	2.47-3.59 mg/l	2.07 mg/l
Total P	-----	-----	17.6 mg/l
Ret. Time	-----	4.5-5.3 days	-----
Pond Depth	-----	3.3 feet	-----
Inlet BOD <sub>5</sub>	-----	165 mg/l	-----
Inlet Sus. Solids----	-----	175 mg/l	-----

#### 1.3.5.3 University of Florida Studies

A research team at the University of Florida at Gainesville, Florida has conducted numerous studies concerning the role of water hyacinths in wastewater treatment. Their reports indicate that suspended solids and BOD<sub>5</sub> were sufficiently removed to meet current requirements, but that nutrient removal,

### 1.3.5.3 (continued)

specifically nitrogen, depended primarily on retention time and pond depth. Nitrogen removal increased with increasing retention time and decreased with increasing pond depth. Under conditions of this study, a retention time of 96 hours and a depth of one (1) foot were optimal. The following tables summarize data collected by the University of Florida at Gainesville.

Parameter	Effluent Char.	Influent Char.
Sus. Solids	9.40 mg/l	11.80 mg/l
BOD <sub>5</sub>	3.84 mg/l	4.23 mg/l
Total N	4.69 mg/l	5.79 mg/l
Total P	4.51 mg/l	5.46 mg/l
Retention Time-----	15 hours	
Pond Depth-----	4.5 feet	

Table VI illustrates results collected on nutrient removal as a function of pond depth and retention time:

Parameter	Influent Char.	Ret. Time	Effluent Characteristics		
			1.1 ft.	2.1 ft.	2.3 ft.
Total N	13.68 mg/l	24 hours	2.86 mg/l	3.08 mg/l	3.33 mg/l
	13.68 mg/l	48 hours	1.82 mg/l	2.30 mg/l	2.90 mg/l
Total P	3.44 mg/l	24 hours	5.89 mg/l	7.95 mg/l	11.49 mg/l
	3.44 mg/l	48 hours	2.72 mg/l	4.98 mg/l	6.85 mg/l

It is evident from the above studies that a water hyacinth-based system could be designed to achieve pollutant removal sufficient to merit serious consideration as a tertiary treatment alternative. There are, however, a number of parameters that need to be ascertained. These include retention time, pond depth, extent of hyacinth cover, harvesting frequency, temperature, surface loading rates and influent characteristics.

### 1.3.6 Design Criteria

Although the above-mentioned studies have tried to identify the effects of a number of parameters on an experimental water hyacinth-based system, it is difficult to obtain specific design criteria for general applicability. Some pertinent observations concerning the factors involved are as follows:

- 1.3.6.1 Plant growth and removal efficiencies decline in the colder months (September to March), particularly in reference to latitude;
- 1.3.6.2 Hyacinth detritus contributes to the nutrient levels in the effluent. This phenomenon becomes more apparent in the colder season;
- 1.3.6.3 Retention time depends not only on hydraulic loading rates and surface area of the pond, but also on harvesting frequency of water hyacinths;
- 1.3.6.4 Harvesting frequency is dictated by the desired degree of water hyacinth cover to prevent the onset of anaerobic conditions, as well as to stimulate pollutant removal with new plant growth;
- 1.3.6.5 Pond depth is determined by the desired retention time and available land area, as well as by the necessity of preventing anaerobicity; and,
- 1.3.6.6 The rate of influent nutrient removal depends on the concentration of nutrients in the water. The limiting nutrient is reportedly nitrogen, which indicates that the presence of this element is necessary for any significant removal of phosphorus.

Final selection of a suitable test site for potential implementation of a water hyacinth-based wastewater treatment demonstration project should be based upon the above criteria. A principle objective of such a project should be definition of design criteria for such a system, as well as utilization of harvested water hyacinths.

### 1.3.7 Site Selection Guidelines

Guidelines set for the site selection phase of contract NASW-3091 were as follows:

1.3.7 (continued)

- 1.3.7.1 The area under consideration would be limited to South Texas and South Florida because of climatic conditions;
- 1.3.7.2 Community size would be limited to 20,000 persons or less;
- 1.3.7.3 Availability of land, if required;
- 1.3.7.4 Performance of the treatment system presently in use;
- 1.3.7.5 Regulatory philosophy concerning the use of ponds and water hyacinths in wastewater treatment; and
- 1.3.7.6 Stage of planning in reference to meeting the 1977 and/or 1983 wastewater quality standards.

## 2.0 ACCOMPLISHMENTS

### 2.1 Contract Activity Narrative

On August 25, 1977, the Interim Report for contract NASW-3091, SB6338(a)77C-217 "The Feasibility of Establishing Operational Water Hyacinth-Based Systems at the Treatment Facilities of Existing Cities," was transmitted to NASA Headquarters, Washington, D.C.; the National Space Technology Laboratory, Bay St. Louis, Mississippi; and the U. S. Small Business Administration, Houston, Texas.

This report outlined contract activities conducted from February, 1977, through August, 1977. These included establishing contacts with the Florida Department of Environmental Regulation, the Texas Water Quality Board, the Texas Department of Parks and Wildlife, and the National Space Technology Laboratory. Information gathered from these sources proved extremely useful in conducting interviews with officials responsible for wastewater treatment in the various communities of South Florida and South Texas considered under the parameters of this study.

Activities conducted under this contract from August, 1977, to the present time include several interviews with officials in both South Texas and South Florida, as well as continued research into engineering and other research data available in the field.

During the month of September, 1977, Caspan Corporation conducted a number of conversations with Mr. Ronald Blackburn, Environmental Specialist with the Florida Department of Environmental Regulation, gathering information on small communities in southern Florida under his jurisdiction. Mr. Blackburn suggested Caspan contact the cities of Punta Gorda and Naples, as he felt they fell within the parameters of this survey. A personal interview with Mr. Blackburn was conducted toward the latter portion of the month to gather further information on a number of small communities. A great deal of information on "the state of the art" of wastewater treatment in Florida was noted, along with the prevailing official philosophies on discharge and water hyacinths, as well as problems encountered peculiar to Florida. In summary, this meeting was very productive.

Mr. Robert Hollander, Punta Gorda City Manager, and Mr. George Patterson, Naples City Manager, were also contacted during the month of September, with a meeting held with Mr. Hollander at his offices in Punta Gorda during the latter part of the month to discuss Punta Gorda's wastewater treatment system.



In September, Caspan Corporation also met with Mr. J. O. Clark, Wastewater Treatment Plant Manager for several small Texas communities under the jurisdiction of the Lower Rio Grande Valley Pollution Control Authority. Mr. Clark provided a great deal of information as well as general data on South Texas and the prevailing wastewater treatment methods employed in the area. This was another very productive meeting.

During the month of November, 1977, Caspan Corporation produced a steady effort in assimilating all data collected into a comprehensive, homogeneous aggregate. Information collected through literature research, personal interviews, meetings, and conversations has been edited and organized, and graphic presentations composed.

The following represents a compilation of data on Texas and Florida facilities gathered under the parameters of contract NASW-3091, SB6338(a)77C-217.

## 2.2 Survey of Texas Facilities

### 2.2.1 Introduction

The lower Rio Grande valley is particularly suited to the application of water hyacinths as a wastewater treatment option. From a physiographic viewpoint, the deep alluvial soils and distinctive economy cause the area to be classified as a sub-region of the Gulf Coastal Plain.

The Valley concentrates Texas' greatest citrus/winter vegetable production area because of the normal absence of freezing temperatures and the rich delta soils of the Rio Grande. Despite occasional damaging frosts, the lower Valley ranks high among the nation's intensified fruit and truck crop regions. Much of the acreage is irrigated from the Rio Grande, although dry-land farming is also practiced.

In surveying possible Texas sites in the lower Rio Grande valley, cities were selected primarily in Cameron and Hidalgo counties because of their extreme southern location and therefore, absence of killing freezes.

### 2.2.2 Cameron County

Cameron County lies at the juncture of the Rio Grande and the Gulf of Mexico in the southernmost point of Texas. Brownsville, San Benito, and Harlingen are the major cities of the Standard

Metropolitan Statistical Area (SMSA) there, which has a 1970 census population of 140,368. Cameron County as a whole has an area of 896 square miles.

A semi-tropical climate gives Cameron County a 341-day growing season, making it one of the nation's principal sources of citrus fruits and winter vegetables. Cameron's mild winters also attract many tourists and encourage retired persons to make their homes in the area.

Cameron's annual precipitation rate of 26 inches is supplemented by irrigation from the Rio Grande for farming. No significant amount of snow has been reported by the National Weather Service.

As part of the Coastal Plain, Cameron County is relatively flat, with the highest altitude of 57 feet recorded at Brownsville. January mean minimum temperature there is 51 degrees and July mean maximum temperature, 95 degrees.

Agribusiness, shipping, tourism and light industry are the major commercial activities. Of the total work force, 72% are employed by private industry and 17.3% by government.

### 2.2.3 Hidalgo County

Created in 1831 from Cameron and Starr Counties, Hidalgo County lies to the west of Cameron in the extreme southern portion of Texas. McAllen, Edinburg and Pharr form the SMSA for the county, having a 1970 census population of 181,535 and a county area of 1,543 square miles.

A long growing season and mild climate make this area a production center for citrus fruits and vegetables. Agribusiness associated with fruits and vegetables, cotton production, and livestock management are principle economic factors in the county. Hidalgo's mild climate and Mexican border location make it an attractive place for tourists and retired persons as well.

Annual average rainfall in the county is 19.29 inches and farming requires supplemental irrigation for most types of production. No significant amount of snow has been recorded.

Highest recorded altitude in the county is 122 feet at McAllen, where the January mean minimum temperature is 49 degrees and the July mean maximum temperature, 97 degrees.

#### 2.2.4 Conclusion

There are several communities within this general two-county geographic area which may serve as possible sites for water hyacinth-based wastewater treatment facilities.

The following represents data collected on each community in Texas surveyed under the parameters of this study.

#### 2.2.5 Edcouch

##### 2.2.5.1 Community Description

Edcouch, located in Hidalgo County, had a 1970 census population of 2,656, and is the smallest of the South Texas communities considered as possible sites for water hyacinth-based wastewater treatment facilities.

Education in this city is generally low, with only 16% of the adult population over 25 having finished four (4) years of high school. The average number of years of education is 5.7.

Median income for this community is \$4,461 per year with a per capita income of only \$1,546. Unemployment is low for both sexes and the major fields of employment include the categories and percentages of the total work force as shown in table VII.

<u>Parameter</u>	<u>Percentage</u>
Wholesale and Retail Trade.....	30%
Light Industry.....	24%
Professional and Related Services.....	17%
Educational Services.....	12%

##### 2.2.5.2 Wastewater Treatment System

The Edcouch wastewater treatment plant is owned and operated by the Rio Grande valley Pollution Control Authority and is located 0.5 miles east of the city. Beginning operations in 1955, it has a Texas permit number of TX0057614.

The Edcouch wastewater treatment plant consists of an Imhoff tank, followed by 1.65 acres of oxidation pond. Effluent from this treatment plant reaches the Laguna Madre estuary, segment number 2491, via a drainage ditch and the North Floodway. This section of the Laguna Madre is used for both contact and non-contact recreation, as well as the propagation of fish and wildlife, therefore, standards include dissolved oxygen content of not less than 4.0 mg/l, a pH range of 6.0-9.0, and a temperature of not more than 95 degrees.

Current loading for the Edcouch wastewater treatment plant includes an average annual daily flow rate of 180,000 gallons, with a peak flow rate of 250,000 gallons in dry weather and 400,000 gallons in wet weather. Edcouch also has a separate stormwater collection system with major problems of infiltration during times of heavy rainfall. Raw influent has a BOD<sub>5</sub> averaging 140 mg/l and suspended solids averaging 180 mg/l. Figure 1 illustrates the Edcouch wastewater treatment system.

#### 2.2.5.3 Plant Performance Characteristics

Table VIII represents performance data on the Edcouch wastewater treatment plant on an average annual basis:

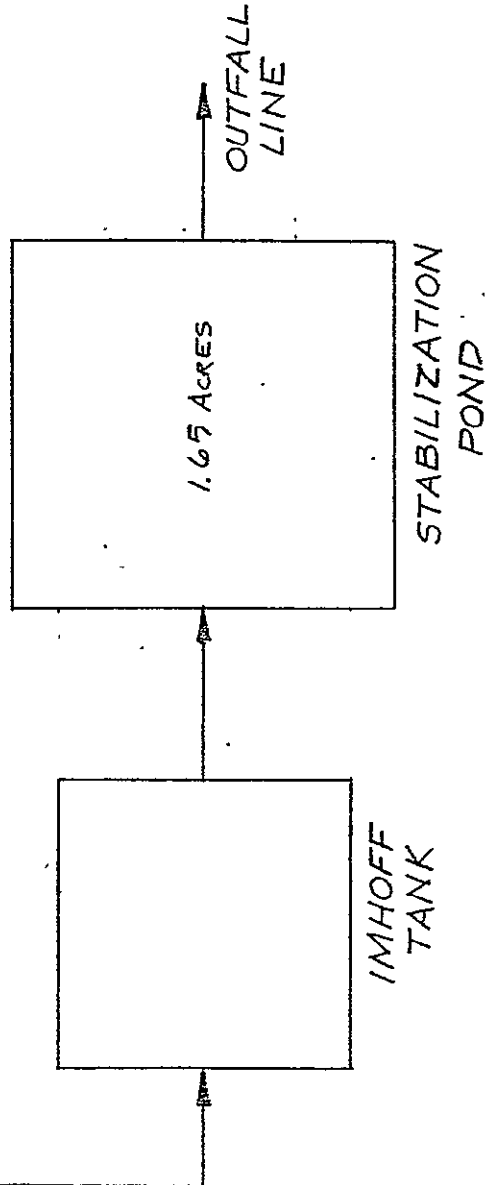
<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	180,000 gal/day
Peak Flow.....	400,000 gal/day
Suspended Solids (effluent).....	58 mg/l
BOD <sub>5</sub> (effluent).....	38 mg/l
Dissolved Oxygen.....	2.0 mg/l
pH (minimum).....	7.0
pH (maximum).....	8.5

Analysis of the above data reveals the average BOD<sub>5</sub> is slightly higher than the NPDES requirement of 30 mg/l and that no data have been recorded for the fecal coliform count.

# EDCOUCH STP

DESIGN POP. UNKNOWN  
POP. SERVED 3000

P. 14



Edcouch plant operation personnel include one (1) managing plant supervisor, two (2) operators, and one (1) clerical/office worker, for a total of four (4) employees.

#### 2.2.5.4 Facility Upgrading Requirements

The primary requirement not met by this wastewater treatment plant is that of BOD<sub>5</sub> loading. Both the hydraulic and organic loading of the plant are inadequately treated due to insufficient treatment pond capacity. An increased service area has added to the pond overload.

#### 2.2.5.5 Community Support

Mr. J. O. Clark, Plant Manager for the Lower Rio Grande Valley Pollution Control Authority which operates the Edcouch wastewater treatment facility, has expressed a very high level of interest in the water hyacinth program and noted the community's pond system would be made available in the event of selection as an implementation site.

### 2.2.6 La Feria

#### 2.2.6.1 Community Description

La Feria, located in Hidalgo County, had a 1970 census population of 2,964. General educational levels were somewhat low, but slightly higher than those of Edcouch with 14% of the adult population over 25 having finished four years of high school. The average number of years of school completed, however, was 9.1.

Median income for this community is approximately \$4,000 per year with a per capita income of only approximately \$1,400. Unemployment for males is 8.1% and 5.4% for females. Major fields of employment include the categories and percentages of the total work force as shown in Table IX.

<u>Parameter</u>	<u>Percentage</u>
Wholesale and Retail Trade.....	33%
Professional and Related Services.....	17%
Light Industry.....	15%
Educational Services.....	13%

#### 2.2.6.2 Wastewater Treatment System

The La Feria wastewater treatment plant is owned and operated by the City of La Feria. Located 1.3 miles south of the city on FM 506, the plant consists of an aeration ditch of a racetrack design, followed by a stabilization pond. This plant has a design flow of 432,000 gallons per day and a design population of 4,500 persons.

Beginning operations in August, 1968, the La Feria wastewater treatment plant has a state permit number of TX0032689. Figure 2 shows a plot plan of the facility.

Receiving water for La Feria effluent is the Arroyo Colorado. This stream has pertinent standards of 4.0 mg/l dissolved oxygen, pH range of 6.7-8.5, a fecal coliform count of 2,000 per 100 ml, and a temperature maximum of 95 degrees.

Current plant loading includes an average daily flow rate of 391,000 gallons. Peak flow rate in dry weather is 378,000 gallons and in wet weather, 429,000 gallons per day. With no industrial waste input into this system, the actual population served is approximately 2,900.

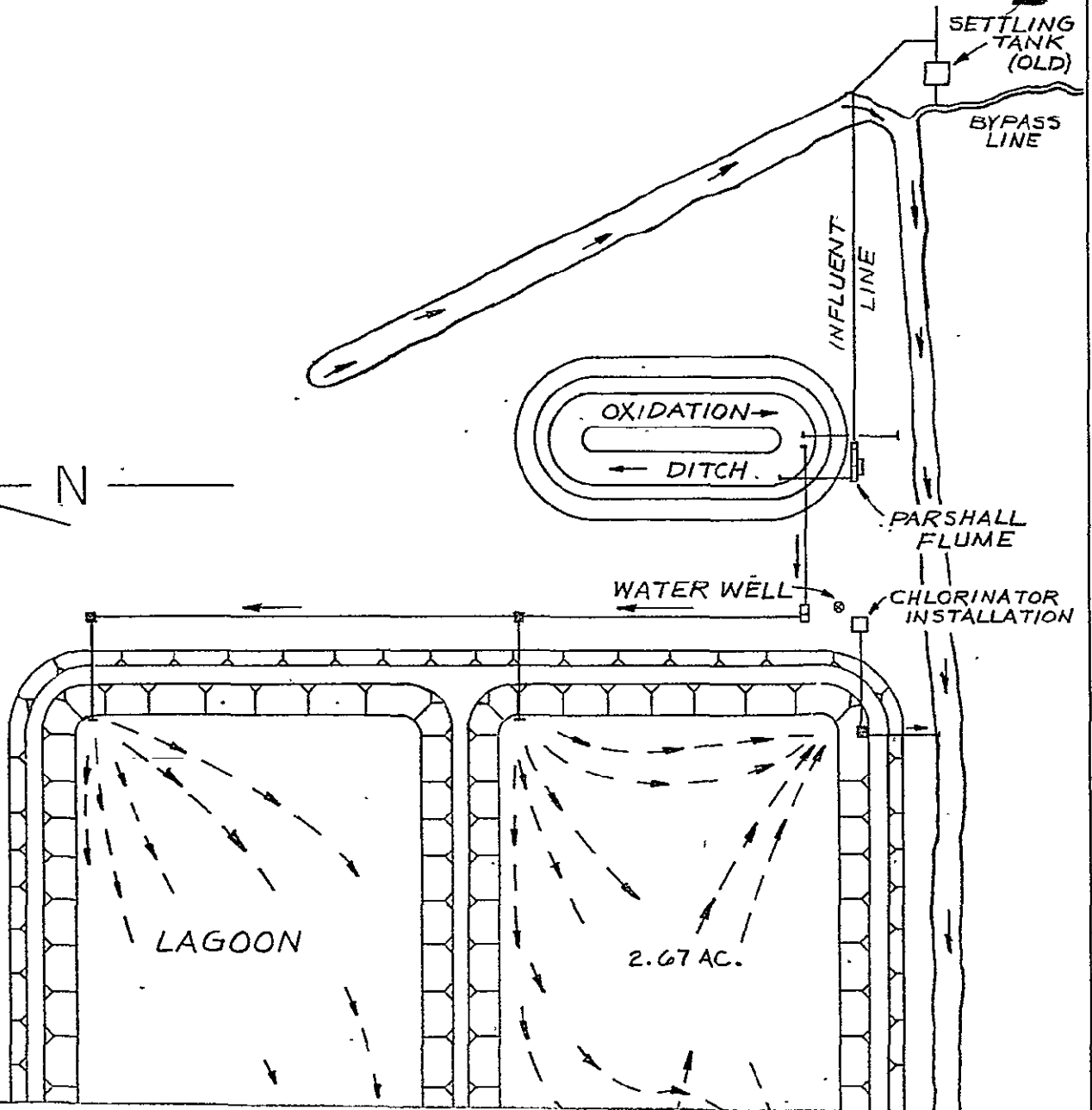
#### 2.2.6.3 Plant Performance Characteristics

Performance characteristics of the La Feria wastewater treatment plant on an average annual basis are as shown on table X.

CITY OF LA FERIA

DESIGN POP. 4,500  
POP. SERVED 2,900

0.11





<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	370,000 gal/day
Peak Flow.....	429,000 gal/day
Suspended Solids (effluent).....	96.8 mg/l
BOD <sub>5</sub> (effluent).....	26.3 mg/l
pH (minimum).....	6.0
pH (maximum).....	9.0

The La Feria wastewater treatment plant has no facilities for chlorination of effluent; however, the plant appears to conform to all NPDES permit requirements, with the exception of suspended solids and fecal coliform count. NPDES requirements for these criteria are 30 mg/l suspended solids and 200 per 100 ml effluent coliform count.

There are six (6) employees of the City of La Feria involved in plant operation, including one (1) management supervisor, one (1) operator, one (1) laboratory technician, one (1) maintenance specialist and two (2) office/clerical workers.

#### 2.2.6.4 Facility Upgrading Requirements

Primary problems at this wastewater facility are the lack of an alternative power source, excessive infiltration during heavy rainfall, and the failure to achieve suspended solids levels required by the NPDES permit.

#### 2.2.6.5 Community Support

Community interest in a proposed demonstration site for a water hyacinth-based wastewater treatment system was low, as expressed by community authorities.

## 2.2.7 Cotulla

### 2.2.7.1 Community Description

The City of Cotulla has a 1970 census population of 3,145, and is located in LaSalle County in southern Texas. Educational levels are average for the area with approximately 15% of the adult population over 25 having completed four years of high school. The average number of school years completed, however, is 8.4.

Median income for this city is approximately \$4,000 per year with per capita income of approximately \$1,400. Unemployment levels are also average for the area with 7.5% of all males in the work force unemployed and 5.2% of all females in the work force without jobs. Major fields of employment include wholesale and retail trade, professional and related services, educational services and light industry.

### 2.2.7.2 Wastewater Treatment System

The Cotulla wastewater treatment plant is owned and operated by the City of Cotulla. It is located on the east side of Hidalgo street within the city limits.

The Cotulla wastewater treatment plant consists of a packaged circular treatment system, followed by wastewater treatment lagoons. The average design flow for this system is 254,000 gallons per day with a design equivalent population of 4,100 people. The NPDES permit number for this facility is TX0027499. Figure 3 features a plot plan of the Cotulla wastewater treatment facility.

After passing through the effluent treatment system, Cotulla's wastewater flows into Mustang Creek and the Nueces River. This receiving system is destined for contact and non-contact recreation and the propagation of fish and wildlife. Stream standards have been set at 5.0 mg/l dissolved oxygen, pH range of 6.5-8.5, and a fecal coliform count of 1000 per 100 ml of water.



Current loading for Cotulla's wastewater treatment plant includes an average daily flow rate of 173,000 gallons per day. The peak flow rate in dry weather is 158,000 gallons per day and in wet weather, 204,000 gallons. Analysis of available data indicates the average annual BOD<sub>5</sub> of raw sewage to be 80 mg/l, with suspended solids at 98 mg/l. In addition, Cotulla's separate stormwater collection system has major infiltration problems during heavy rainfall.

#### 2.2.7.3 Plant Performance Characteristics

On an average annual basis, Table XI represents plant performance characteristics for the Cotulla wastewater treatment system.

<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	173,000 gal/day
Peak Flow.....	204,000 gal/day
Suspended Solids (effluent).....	124 mg/l
BOD <sub>5</sub> (effluent).....	34 mg/l
pH (minimum).....	6.2
pH (maximum).....	8.8

There are four (4) persons employed in the operation of this wastewater treatment plant, including a management supervisor, operator, laboratory technician, and an office/clerical worker.

#### 2.2.7.4 Facility Upgrading Requirements

The major facility upgrading requirement is that of chlorination equipment at the effluent discharge point.

#### 2.2.7.5 Community Support

Community interest in a proposed water hyacinth-based wastewater treatment system would not be very high as this city finds its treatment system very close to total compliance. Changeover to water hyacinth treatment from its present system does not appear very attractive, as expressed by community authorities.

## 2.2.8 Alamo

### 2.2.8.1 Community Description

The City of Alamo had a 1970 census population of 4,291 with 12% listed as foreign-born citizens. Only 10% of the total adult population over 25 finished four years of high school, while the average number of school years completed was 6.2.

Median income for this small South Texas community is \$3,806 per year with a per capita income of only \$1,251. Seven per cent (7%) of the families listed in the 1970 census were farm families, but the major fields of employment break down as shown in Table XII.

<u>Parameter</u>	<u>Percentage</u>
Wholesale and Retail Trade.....	34%
Light Industry.....	29%
Manufacturing.....	10%
Manufacturing of Durable Goods.....	5%

Unemployment is low for males with only 5% of the total work force without jobs, while female unemployment is over twice that figure at 11.1%.

### 2.2.8.2 Wastewater Treatment System

The Alamo wastewater treatment plant is owned and operated by the Lower Rio Grande Valley Pollution Control Authority. The plant is located two miles south of the city on Tower Road and treatment consists of an Imhoff tank followed by a trickling filter and oxidation lagoons.

This plant began operations in 1952 and has a state permit number of TX0057622.

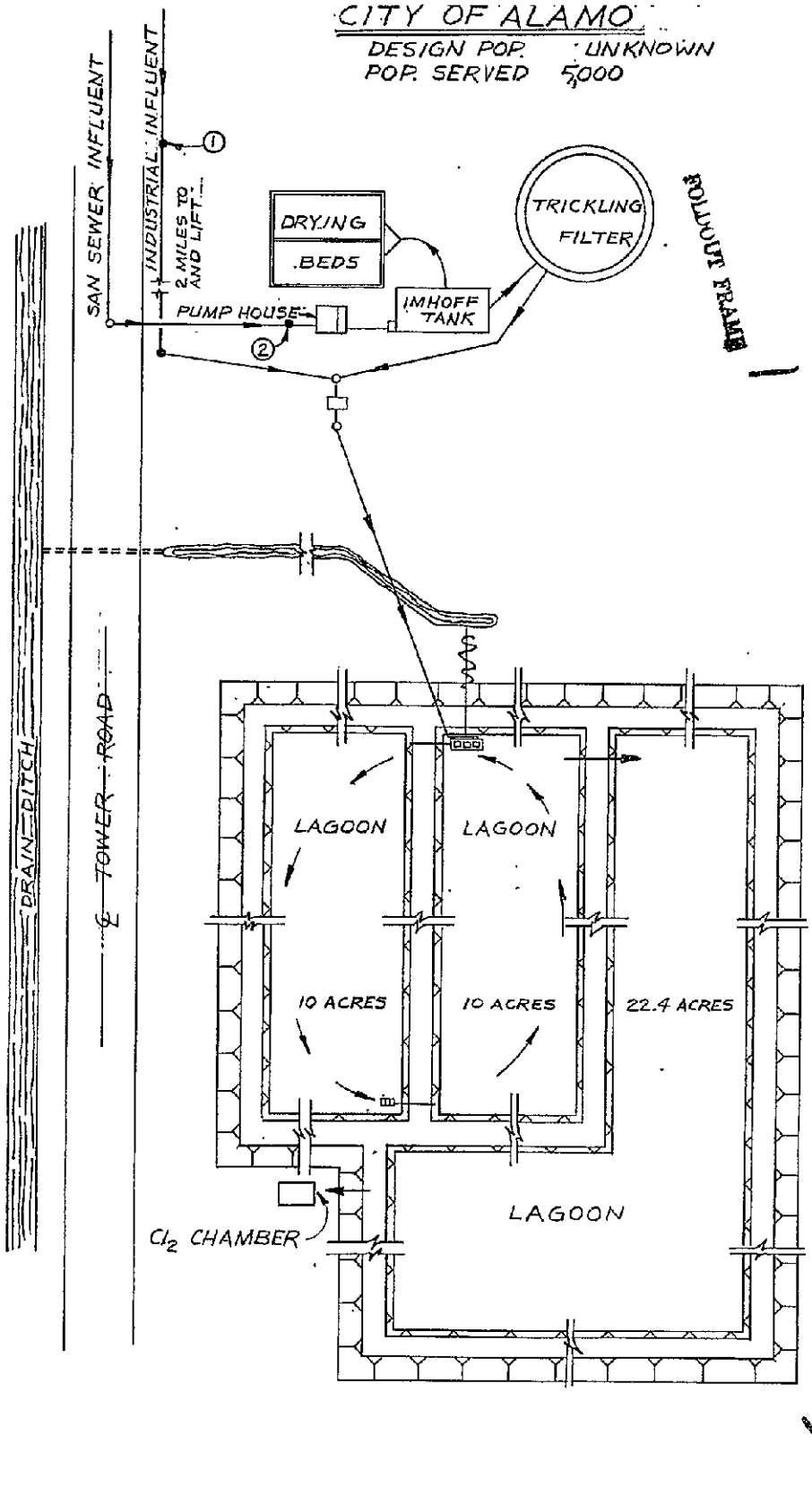


Figure Four

DR.	E. TATUM	DATE	11-9-77
CH.			
AP.	S.P. 11-10-77		

CASPAN CORPORATION



JOB	7719	REV.	0
DWG. NO.	7719-B-1003		

Receiving water for Alamo's effluent is the Arroyo Colorado segment number 2201. This stream has pertinent standards of 4.0 mg/l of dissolved oxygen, pH range of 6.7-8.5, a fecal coliform count of 200 per 100 ml of water and a maximum temperature of 95 degrees.

Current plant loading includes an annual average daily flow rate of 278,000 gallons per day and a peak flow rate in dry weather of 314,000 gallons with wet weather peak flow listed as 400,000. Analysis of data indicates BOD<sub>5</sub> is 314 mg/l and suspended solids are listed at 5500 mg/l for this plant. Figure 4 shows a plot plan of the Alamo wastewater treatment facility.

#### 2.2.8.3 Plant Performance Characteristics

Performance of the Alamo wastewater treatment plant is summarized in Table XIII on an average annual basis.

Table XIII

<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	278,000 gal/day
Peak Flow.....	314,000 gal/day
Suspended Solids (effluent).....	63.0 mg/l
BOD <sub>5</sub> (effluent).....	24.3 mg/l
Fecal Coliform (effluent).....	100
pH (minimum).....	6.9
pH (maximum).....	8.4

The City of Alamo employs four (4) persons to operate the wastewater treatment plant, including one (1) supervisor, two (2) operators, and one (1) office/clerical worker.

#### 2.2.8.4 Facility Upgrading Requirements

The primary requirement not being met by this plant is suspended solids. There are 42.2 acres of lagoons producing suspended solids at levels above the Texas Department of Water Resources standards.

#### 2.2.8.5 Community Support

Mr. J. O. Clark, Plant Manager for the Lower Rio Grande Valley Pollution Control Authority, which operates the Alamo wastewater treatment facility, has expressed a very high level of interest in the water hyacinth program and said the community's entire resources would be put at the disposal of such a program if Alamo is chosen as a demonstration site.

#### 2.2.9 San Juan

##### 2.2.9.1 Community Description

The City of San Juan has a 1970 census population of 5,070 with 12% of the population listed as foreign-born and only 2% listed as farm families. Educational levels attained by the total adult population over 25 were slightly higher than the previous four cities discussed in this report with 17% of them having completed four years of high school and the average number of years completed being 7.6.

Median income for the City of San Juan, according to the 1970 census, was \$4,281 with per capita income listed at \$1,375. Unemployment was nearly equal for the sexes with 3.2% unemployed males and 4.6% unemployed females. Major fields of employment and percentages for the total work force break down as shown in Table XIV.

<u>Parameter</u>	<u>Percentage</u>
Wholesale and Retail Trade.....	30%
Light Industry.....	25%
Professional and Related Services.....	19%
Educational Services.....	11%



#### 2.2.9.2 Wastewater Treatment System

The San Juan wastewater treatment system is owned and operated by the Lower Rio Grande Valley Pollution Control Authority, state permit number TX0057592, and consists exclusively of 11.7 acres of oxidation lagoons.

Receiving water for effluent from the San Juan system is the Arroyo Colorado, which has stream standards of 4.0 mg/l dissolved oxygen, fecal coliform count of 2,000, pH range of 6.7-8.5, and a maximum temperature of 95 degrees. This stream is used for both contact and non-contact recreation as well as the propagation of fish and wildlife.

Current plant loading indicates an average annual daily flow rate of 326,000 gallons per day with peak flow in dry weather of 326,000 gallons per day and in wet weather of 600,000 gallons per day.

Lower Rio Grande Valley Pollution Control Authority records indicate the average BOD<sub>5</sub> of raw sewage into the San Juan system is 250 mg/l with suspended solids of 240 mg/l. This system has some industrial waste discharges from food processing plant activities on a seasonal basis, but infiltration problems occur only during heavy rainfall in a separate stormwater collection system owned by the City of San Juan. A plot plan of the San Juan wastewater treatment facility was unavailable from community authorities.

#### 2.2.9.3 Plant Performance Characteristics

Analysis of the average annual daily performance of the San Juan sewage treatment facility yields the following summary as shown in Table XV.

Parameter	Data Results
Average Flow.....	326,000 gal/day
Peak Flow.....	600,000 gal/day
Suspended Solids (effluent).....	88 mg/l
BOD <sub>5</sub> (effluent).....	44 mg/l
Fecal Coliform.....	21
pH (minimum).....	7.5
pH (maximum).....	8.9

The Lower Rio Grande Valley Pollution Control Authority employs five (5) persons to operate the San Juan plant, including one (1) supervisor, one (1) operator, two (2) maintenance persons, and one (1) office/clerical worker.

#### 2.2.9.4 Facility Upgrading Requirements

Excessive total suspended solids constitute the main permit requirements not being met by this treatment facility.

#### 2.2.9.5 Community Support

Very high interest has been expressed by the Lower Rio Grande Pollution Control Authority for a possible demonstration site for water hyacinth-based wastewater treatment.

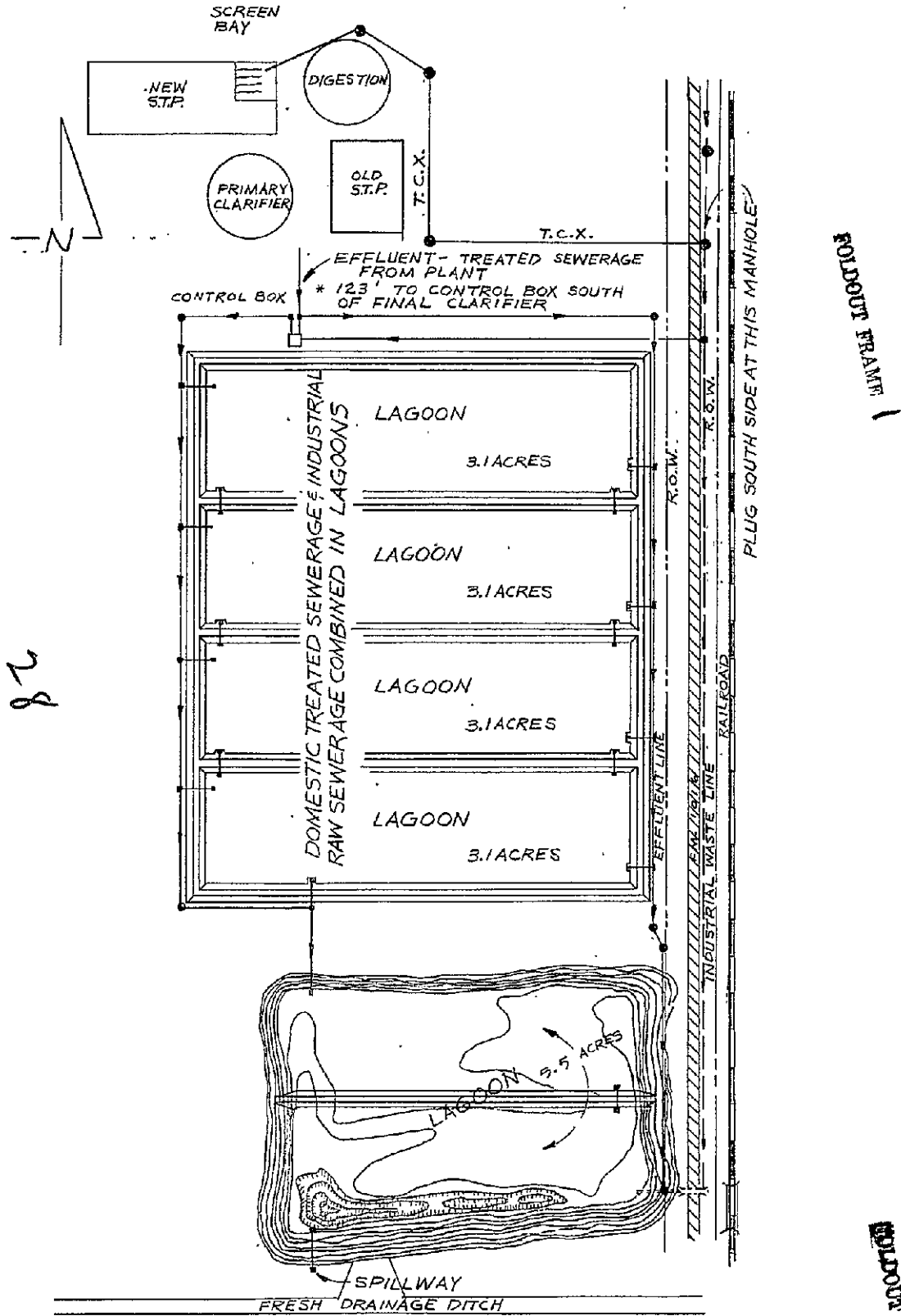
### 2.2.10 Mission

#### 2.2.10.1 Community Description

The City of Mission, located in southwest Hidalgo County, is a center for screw worm eradication and is one of the largest communities discussed thus far, with a 1970 census population of 13,043. Educational levels were fairly high, with 17% of the total adult population over 25 having finished four years of high school. The average number of years of school finished, however, was listed in the census at 8.0.

Median income for persons living in Mission was \$5,161 with a per capita income of \$1,517. Unemployment levels were listed at 6.2% for males and 4.0% for females. Major fields of employment and their percentages of the total work force are listed in Table XVI.

<u>Parameter</u>	<u>Percentage</u>
Crafts.....	14%
Operatives.....	13%
Services.....	11%
Farmers.....	10%



CITY OF MISSION  
 DESIGN POP. 15,000  
 POP. SERVED 13,043

Figure Five

DR. E. TATUM	DATE 11-8-77	CASPAN CORPORATION	JOB 7719	REV.
CH. <i>[Signature]</i>			DWG. NO. 7719-B-1001	0
AP. S.P. 11-10-77				

#### 2.2.10.2 Wastewater Treatment System

The Mission wastewater treatment plant, located one mile south of the city on FM 1016, is owned and operated by the City of Mission. This system consists of a combined storm and municipal collection system flowing into a primary clarifier, two trickling filters, a final clarifier and 12.5 acres of oxidation lagoons in series, followed by a 5.5 acre polishing lagoon.

Receiving water for Mission plant effluent is the Arroyo Colorado, which has a dissolved oxygen standard of 4.0 mg/l, a pH range of 7.0-9.0, and a fecal coliform count of 70 per 100 ml. Current plant loading includes an annual average daily flow rate of 584,000 gallons and peak flow rate in dry weather of 615,000 gallons per day, with wet weather flow peaking at 2,112,000 gallons per day.

Annual average BOD<sub>5</sub> of the raw sewage is 97 mg/l, while the suspended solids annual daily average is 115 mg/l. Wastewater flow into this system includes industrial wastes from a citrus juice plant, having a population equivalent of 8,000 persons. This is seasonal flow, averaging 2,000 gallons per day. In addition, this system has severe infiltration problems during heavy rainfall. Figure 5 shows the plot plan of the Mission wastewater treatment facility.

#### 2.2.10.3 Plant Performance Characteristics

Table XVII represents plant performance characteristics on an annual average daily basis.

<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	584,000 gal/day
Peak Flow.....	2,112,000 gal/day
Suspended Solids (effluent).....	27 mg/l
BOD <sub>5</sub> (effluent).....	14 mg/l
Dissolved Oxygen (effluent).....	6.8 mg/l
pH (minimum).....	6.8
pH (maximum).....	8.4

The City of Mission employs six (6) persons to operate their wastewater treatment plant including management, operators, laboratory technicians, maintenance, and clerical workers.

#### 2.2.10.4 Facility Upgrading Requirements

The Mission collection system has severe infiltration problems during heavy rainfall, resulting in excessive hydraulic overloading of the treatment plant. In addition, this plant apparently does not achieve suspended solids effluent standards as required by the NPDES permit.

#### 2.2.10.5 Community Support

Although a larger community such as Mission would have more money and personnel to devote to a water hyacinth-based wastewater treatment program, community authorities did not express a high level of interest in the possibility of a demonstration site for the program. One of the main criticisms expressed of such a program is the long period of time required for obtaining the necessary permits and the length of the experiment (usually one year). Implementation would be difficult under these conditions.

### 2.2.11 Weslaco

#### 2.2.11.1 Community Description

Weslaco, located in Hidalgo County, has a 1970 census population of 16,183, making it the next largest of the communities under consideration as possible sites for water hyacinth-based wastewater treatment facilities. Educational levels were high within the SMSA of Edinburg, Pharr, and McAllen, which includes Weslaco. Over one-third (35.5%) of the total adult population over 25 had completed four years of high school with the average number of years of education completed listed at 8.4.

Median income for this SMSA was \$5,276, with a per capita income listed at \$1,681. Unemployment was nearly equal for the sexes with 5.0% of males out of work and 6.1% of females jobless. Major fields of employment are as shown in Table XVIII.

<u>Parameter</u>	<u>Percentage</u>
Clerical.....	14%
Professional and Related Services.....	13%
Operatives.....	11%
Services.....	10%

#### 2.2.11.2 Wastewater Treatment System

The Weslaco wastewater treatment plant is owned and operated by the City of Weslaco. Located on Airport Drive near Highway 83, the plant began operations in 1971 and has a Texas permit number of TX0052787. Sewage treatment consists of trickling filters followed by oxidation ponds and polishing lagoons. Average annual design flow for this system is 3,500,000 gallons per day with a design population of 26,700.

Effluent from the Weslaco wastewater treatment system flows into the North Floodway, thence to the Laguna Madre. This section of receiving water lists stream standards of 4.0 mg/l dissolved oxygen, a pH range of 7.0-9.5, and temperature maximum of 95 degrees. The Laguna Madre is used for both contact and non-contact recreation.

Current plant loading includes an annual average daily flow rate of 1,900,000 gallons per day with peak flow in dry weather of 1,700,000 gallons per day and peak flow in wet weather of 2,300,000 gallons per day. Annual average BOD<sub>5</sub> of raw sewage is 134 mg/l with suspended solids of 166 mg/l.

Although this system has some infiltration problems from a separate storm water collection system during heavy rainfall, the major influent other than domestic wastes is industrial wastes from citrus and vegetable processing plants on a seasonal basis. Estimated at having a population equivalent BOD<sub>5</sub> of 6,000, approximately 1,200,000 gallons per day are dumped into the Weslaco system during the processing period. A plot plan of the Weslaco wastewater treatment facility was unavailable from community authorities.

#### 2.2.11.3 Plant Performance Characteristics

Performance characteristics for the Weslaco wastewater treatment plant are as shown in Table XIX.

<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	1,500,000 gal/day
Peak Flow.....	2,100,000 gal/day
Suspended Solids (effluent).....	55.6 mg/l
BOD <sub>5</sub> (effluent).....	19.0 mg/l
Fecal Coliform (effluent).....	120
pH (minimum).....	6.0
pH (maximum).....	8.0

Eleven (11) persons are employed by the City of Weslaco as plant operating personnel, including one (1) supervisor, two (2) operators, one (1) laboratory technician, six (6) maintenance personnel, and one (1) clerical/office worker.

#### 2.2.11.4 Facility Upgrading Requirements

The primary consideration in upgrading this facility is reducing effluent suspended solids levels.

#### 2.2.11.5 Community Support

Interest in a proposed water hyacinth-based wastewater treatment system for Weslaco was high, as expressed by community authorities.

### 2.2.12 San Benito

#### 2.2.12.1 Community Description

The city of San Benito has a 1970 census population of 18,000, including 4% farm families, making it the largest of the cities discussed in this section of the final report on the feasibility of establishing operational water hyacinth-based systems at the treatment facilities of existing cities.

Educational levels were average for a city of this size with 25.5% of the adult population over 25 having completed four years of high school. The educational mean, however, was only 6.6 years.

Median income for this community was \$4,664, according to the 1970 census figures, with a per capita income of \$1,355. Major job market areas are shown in table X)

#### 2.2.12.1 (continued)

<u>Parameter</u>	<u>Percentage</u>
Services.....	13%
Clerical.....	13%
Crafts.....	12%
Professional and Related Services.....	9%

Unemployment levels for the sexes were nearly equal with 8.2% listed for males and 7.7% for females.

#### 2.2.12.2. Wastewater Treatment System

The San Benito wastewater treatment plant is owned and operated by the city and is located 1.7 miles northwest of the community. The plant consists of five (5) oxidation lagoons in series as defined in table XXI.

<u>Lagoon Number</u>	<u>Surface Area</u>
Lagoon #1.....	19.30 acres
Lagoon #2.....	8.39 acres
Lagoon #3.....	7.08 acres
Lagoon #4.....	8.02 acres
Lagoon #5.....	9.36 acres

Receiving water for effluent from this system is segment 2201 of the Arroyo Colorado. This segment has stream standards of 4.0 mg/l dissolved oxygen, 2,000 per 100 ml fecal coliform count, pH range of 6.5-9.0, and is used for both contract and non-contract recreation, as well as propagation of fish and wildlife.

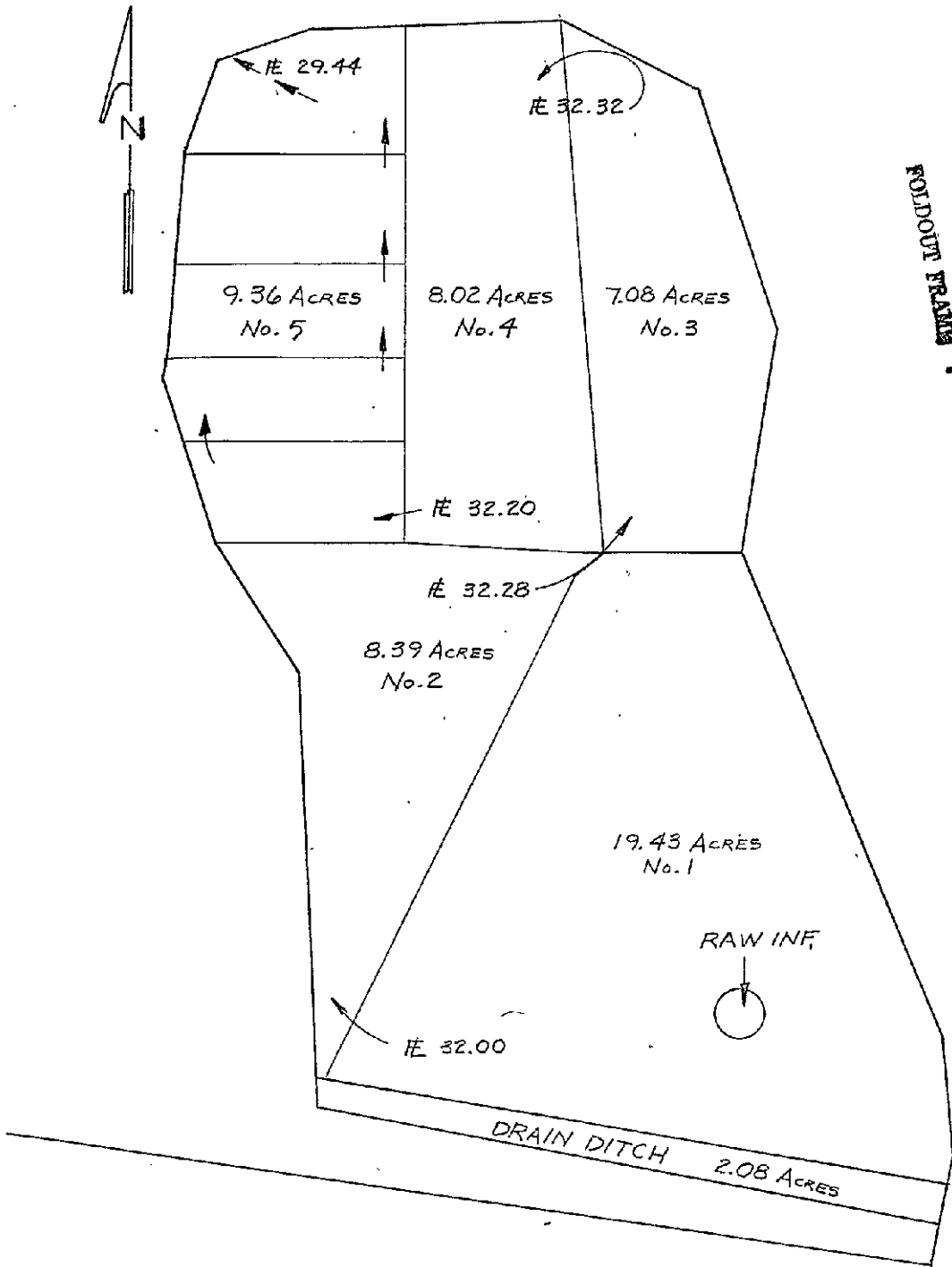
Current plant loading includes an annual average daily flow rate of 747,000 gallons per day, a peak flow rate in dry weather of 1,165,000 gallons per day, with peak in wet weather at 1,150,000 gallons per day. Total flow into this system is 100% domestic with no significant infiltration problems into the separate collection system as shown in the plot plan of the San Benito wastewater treatment system.



# CITY OF SAN BENITO

DESIGN POP.  
POP. SERVED

UNKNOWN  
18,000



FOLDOUT FRAME 1

FOLDOUT FRAME 2

Figure Six

DR. E. TATUM	DATE 11-10-77
<div style="display: flex; justify-content: space-between;"> <span>BY <i>[Signature]</i></span> <span>11-10-77</span> </div>	
<div style="display: flex; justify-content: space-between;"> <span>LE R.P.</span> <span>11-10-77</span> </div>	

CASPER CORPORATION



JOB 7719	REV. 0
DWG. NO. 7719-B-1005	

### 2.2.12.3 Plant Performance Characteristics

Analysis of annual average plant performance data characteristics are shown in table XXII;

<u>Parameter</u>	<u>Data Results</u>
Average Flow.....	747,000 gal/day
Peak Flow.....	1,300,000 gal/day
Suspended Solids (effluent).....	41.0 mg/l
BOD <sub>5</sub> (effluent).....	15.0 mg/l
Fecal Coliform (effluent).....	2132
pH (minimum).....	6.9
pH (maximum).....	8.1

There are eight (8) full and part time plant operation personnel, including supervisors, operators, laboratory, maintenance, and office/clerical workers.

### 2.2.12.4 Facility Upgrading Requirements

The primary problems in meeting permit requirements for this system are reductions in effluent levels of suspended solids and fecal coliform count.

### 2.2.12.5 Community Support

Community support for a water hyacinth-based wastewater treatment system was moderate to high in this Texas community; however implementation of such a system would not be recommended because of the size of the treatment plant currently in use and the nature of permit requirements not being met.

## 2.2.13 Permit Requirements for Water Hyacinth Usage in Texas

Prior to issuance of a permit to use water hyacinths for wastewater treatment in Texas, the Texas Parks and Wildlife Department requires the following information for review, since the United States Environmental Protection Agency has declared the use of water hyacinths suitable only for partial use in the tertiary treatment of wastewater:

### 2.2.13.1 Map of the general location of treatment plants in relation to the county;

#### 2.2.13 (continued)

- 2.2.13.2 Map of sewage lagoons in relation to other waters in the area;
- 2.2.13.3 A sketch of entrapment structures that will prevent the escape of water hyacinth plants into non-infested or previously-treated waters;
- 2.2.13.4 Size, volume and depth of secondary or tertiary treatment lagoons and water retention time;
- 2.2.13.5 A statement as to what specific purposes the use of the water hyacinths is expected to accomplish;
- 2.2.13.6 A list of chemical tests to be conducted, testing procedures, and anticipated results;
- 2.2.13.7 System of monitoring to be used, who will run the chemical tests, and other precautionary measures; and
- 2.2.13.8 Information to substantiate the claim that these studies will be conducted in a controlled environment.

### 2.3 Survey of Florida Facilities

#### 2.3.1 Introduction

Southern Florida has long been considered a haven for retired persons and tourists seeking escape from the wintry blasts of more northerly climes, and the annual average of 215 sunny days makes it an ideal location for citrus fruit production and other types of agriculture as well.

A generally high water table, combined with numerous streams, rivers, and lakes, makes the annual rainfall average of 5.5 inches more than adequate for agricultural, municipal, and industrial purposes.

Population figures, however, show a generally low concentration in comparison with land areas for the southern portion of the state since much of this region is reserved for national parks, wildlife refuges and the like, and therefore is largely uninhabited.

### 2.3.1 (continued)

The southern portion of the Florida peninsula is well suited for the growth and propagation of water hyacinths in wastewater treatment lagoons as January minimum temperatures average 54 degrees and July maximum temperatures average 90 degrees. In fact, southern Florida has been termed "the only region of the United States which can realize this potential (for water hyacinth utilization) on a year-round basis," (Battelle Columbus Laboratories, 1976, "Analysis of the Market Potential of Water Hyacinth-Based Systems for Municipal Wastewater Treatment, p. 20).

Several counties in southern Florida were examined for the purposes of this survey. Collier, Lee, Marion, Palm Beach, and Seminole counties were all rejected because communities contained within their quarters, failed to meet one or more of this study's parameters.

The City of Naples, in Collier county was deemed unsuitable for this survey, with a 1970 census population of 15,784 and a very advanced wastewater treatment system, while the City of Everglades, with a population of 568, failed to have a treatment system suitable for adaption to water hyacinths usage. In addition, neither city was interested in a water hyacinth program as current wastewater treatment philosophy in Florida tends toward eliminating discharge completely, if possible.

Lee county and the City of Fort Myers were rejected because Fort Myers was too large with a 1970 census population of 33,506. Similarly, the City of Ocala in Marion county was also rejected for its size, Ocala has two treatment plants each handling 2.5 million gallons per day. One plant utilizes trickling filters and polishing ponds, while the other plant features aeration tanks and percolation/evaporation ponds with no discharge. Both plants are also in compliance with current permit requirements, although planning work for foreseeable 1983 requirements has not progressed very far.

Similarly, the City of West Palm Beach, in Palm Beach county was also deemed too large for the purposes of this study with a 1970 census population of 60,084.

Finally, the City of Altamont Springs in Seminole county was rejected, although first examination showed a population of under 20,000 at 9,098. Reasons for rejection of Altamont Springs include the fact its wastewater treatment facility currently meets all permit requirements, it is an advanced treatment system,

2.3.1 (continued)

and it has a capacity of 7.7 million gallons per day, making it too large for this survey.

Counties found to at least superficially meet the parameters of this survey were Charlotte, Hendry, Highlands, and Levy counties in the southern portion of the Florida peninsula.

2.3.2 Charlotte County

With a county-wide population of 27,559, according to the 1970 census, Charlotte county contains the city of Punta Gorda, which falls within the parameters of this survey.

2.3.3 Punta Gorda

2.3.3.1 Community Description

The City of Punta Gorda, Florida, listed a 1970 census population of 3,879, 14% of the entire county population. Per capita income for inhabitants of this municipality was listed in the census at \$3,313, as compared with \$2,996 for the county as a whole.

2.3.3.2 Wastewater Treatment System

Wastewater treatment for the City of Punta Gorda is conducted in the city's 1971-built sewage treatment plant, and presently includes tertiary treatment. Influent flows into a primary clarifier, then to a digester, and thence is subjected to extensive aeration and stabilization before flowing into receiving waters.

Punta Gorda's wastewater treatment facility is the only municipal system in the county. Approximately one-third of its users reside outside the city limits. Currently, city legislation is aimed at defining the wastewater collection area as contiguous with the city limits, however.

Other wastewater treatment systems in the county are strictly private and were rejected for the purposes of this study.

#### 2.3.3.2 (continued)

Presently, Punta Gorda's wastewater effluent is not meeting permit standards for nitrogen removal, as the facility was designed and built before more stringent environmental standards were determined. The U.S. Environmental Protection Agency has filed suit against the city of Punta Gorda for failure to meet their effluent requirements; however, the Punta Gorda plant currently meets all phosphorus, suspended solids, fecal coliform, and BOD<sub>5</sub> requirements.

#### 2.3.3.3 Community Participation

Community support and participation in the event of water hyacinth-based wastewater treatment project : start-up would be high, with land for construction of ponds to be made available as needed; however, the high water table and current effluent discharge philosophy in Florida make even this propitious statement invalid.

#### 2.3.4 Hendry County

Hendry county in southern Florida listed a 1970 census population of 13,259, with an average per capita income for its residents of \$2,410. Falling within the guidelines of this survey is the City of Clewiston.

#### 2.3.5 Clewiston

##### 2.3.5.1 Community Description

Clewiston boasts a 1970 census population of 4,110, some 31% of the entire population of Hendry county. Per capita income was listed as \$3,348, substantially greater than the county average.

##### 2.3.5.2 Wastewater Treatment System

Currently the Clewiston wastewater treatment system is a participant in the Florida Department of Environmental Regulation's "201" study to determine the best method of upgrading their facilities to meet current and 1983 water quality standards. Consulting engineers have been hired by the city to study the problem and current preferences lean toward land spreading of effluent, rather than ponding. One philosophy

#### 2.3.5.2 (continued)

holds that bacteria and other effluent components are filtered through the soil, whereas ponding of effluent would not accomplish the same task.

In addition, water hyacinths are looked upon with distaste in general since escaped plants have become such a navigational and biological problem in natural bodies of water.

#### 2.3.5.3 Community Support

Support and participation in establishing a water hyacinth-based wastewater treatment system at the existing sewage plant in Clewiston would be low or non-existent for the above reasons.

#### 2.3.6 Highlands County

Listed in the 1970 U.S. census with a population of 35,285, Highlands county, Florida, is the second most populous of the counties considered in this section of the "Final Report on the Feasibility of Establishing Water Hyacinth-Based Wastewater Treatment Systems at the Facilities of Existing Cities." Average per capita income for this county was listed in the census at \$2,387.

Highlands county contains the City of Avon Park within its borders. This city was selected for consideration in this survey because of its size and the type of wastewater treatment currently employed there.

#### 2.3.7 Avon Park

##### 2.3.7.1 Community Description

This community of 7,449, 21% of the total county population, is located on top of the ridge from which Highlands county receives its name. A small municipality, per capita income was noted at \$2,102 in the census taken in 1970.

##### 2.3.7.2 Wastewater Treatment System

The city of Avon Park operates a wastewater treatment plant outside the city limits bordering on a lake as the receiving water. Treatment includes a percolation

#### 2.3.7.2 (continued)

pond which currently experiences problems with raw effluent leaking through the bottom of the pond into the lake.

Avon Park is also participating in the Florida Department of Environmental Regulation's "201" study program, data results from which are expected to be returned to the DER for analysis sometime toward the end of 1977.

#### 2.3.7.3 Community Support

Community support for establishing an operational water hyacinth-based wastewater treatment facility at this city's sewage plant is expected to be low as the location of the plant would make it very easy for escaped plants to create a navigational and environmental problem in the plant's neighboring lake.

In addition, Avon Park, and Highlands county in general, while falling below the 32nd parallel, (the latitude recommended in the Battelle Columbus Laboratories report), is the most northerly of the cities under discussion in this section. Water hyacinth growth, while still considered to be year-round, may be subjected to occasional cold weather, thus hampering or stalling pollutant absorption.

#### 2.3.8 Levy County

Levy county, second smallest of the Florida counties considered here, listed in the 1970 census a population of only 15, 409, and an average per capita income of \$2,006 for its residents.

#### 2.3.9 Williston

##### 2.3.9.1 Community Description

Located in Levy county is the City of Williston, with a 1970 U.S. census population of 2,230, 15% of the total county population. Per capita income in this community was substantially higher than the county average at \$2,200.



#### 2.3.9.2 Wastewater Treatment System

Williston currently operates a 200,000 gallon per day wastewater treatment plant consisting of a trickling filter and a one-acre evaporation/percolation pond with problems in meeting DER/EPA requirements. A consulting engineering firm has been retained by the city to perform a "201" study to determine the best feasible method of eliminating operating problems and meeting current and 1983 permit requirements.

#### 2.3.9.3 Community Support

Positive community support for a water hyacinth-based wastewater treatment facility was expressed by the Williston City Manager, when contacted by Caspan Corporation for this survey.

Up to seven (7) acres of treatment lagoons could be made available for implementation of such a system; however, initial enthusiasm cooled when consideration of such a system by the engineering firm retained for the "201" study was mentioned, as well as the one-year recommended length of a water hyacinth wastewater treatment study. Therefore, it is unlikely enough community participation would be made available to make feasible a water hyacinth-based study at this location.

#### 2.3.10 Conclusion

In summary, Florida communities surveyed seemed unlikely candidates for water hyacinth-based wastewater treatment facilities. Most of them favored a non-discharging system, and many found it cheaper to convert their present system to land spreading, spray irrigation, or wriggle furrowing of agricultural areas where a commercial outlet for effluent could be found, rather than merely keeping up with increasingly more stringent EPA requirements.

General feelings on the subject of wastewater treatment discharge were succinctly stated by Mr. Ronald Blackburn, Environmental Specialist with the Florida Department of Environmental Regulation:

"Florida is one of the most unique areas you'll find in the United States because of our estuary systems. We're very much against discharges to those systems and you're not going to get much

2.3.10 (continued)

support for discharge when you're talking about coastal areas where people swim and fish."

Obviously, water hyacinths are not favored plants in Florida, regardless of application, as typified by Mr. Richard Morgan, Enforcement Officer with the Florida DER; "It's good to use them somehow while they're around, but I'd like to see them eliminated."

### 3.0 CONCLUSIONS/RECOMMENDATIONS

#### 3.1 Evaluation of Texas Cities as Possible Sites for Water Hyacinth-Based Wastewater Systems

##### 3.1.1 Introduction

Texas cities, in general, seemed very enthusiastic and cooperative when contacted in reference to a proposed water hyacinth-based wastewater treatment system implementation. Combined with their extreme southern locations and general adaptability to water hyacinth treatment, Texas cities surveyed seemed excellent sites for program implementation.

In reference to plant harvesting in the area, several economical possibilities lend themselves to consideration. One of the most direct and simple methods is the use of a drag line for harvesting the hyacinths. Other potential methods would require further study; for example, seeding and harvesting the plants using a containerized cubical format. Any harvesting consideration, however, should be based on empirical knowledge, since actual harvesting methods would have to be refined with experience.

The drying of the plants does not seem to pose a major problem since the South Texas area is a generally semi-arid region. It is recommended that the feasibility of building air-drying racks be explored. This method would reduce the bulk of harvested plants quickly and economically and would readily lend itself to integration with a total disposal system. In addition, any harvesting system should be considered in perspective to the overall cost of the project.

Compatibility for harvested hyacinths in South Texas for agricultural uses appears to be high. Among the potentials for the harvested plants are the generation of biogas, animal food supplements, fertilizer, and soil stabilizer. The most feasible use of harvested water hyacinths, however, appears to be as a fertilizer and soil conditioner. The ability of the area to assimilate projected amounts of harvested hyacinths in agricultural uses appears substantial.

### 3.1.2 Lower Rio Grande Valley Pollution Control Authority (LRGVPCA)

Mr. J. O. Clark is LRGVPCA Plant Manager for the cities of Alamo, Edcouch, and San Juan. He was very responsive to the water hyacinths program when interviewed by Caspan Corporation and suggested using the three cities under his jurisdiction as a "package" in a pilot study. He said the city of San Juan is already completing a small water hyacinths conversion project and the City of Edcouch also has a small (1-3/4 acre) pond converted to water hyacinths growth.

Mr. Clark had some reservations concerning a water hyacinth system implementation in reference to the EPA Construction Grant Program. He felt the EPA grants time lapse was inordinantly long, since it took him a year and a half to complete the paperwork to upgrade the present system and he felt the water hyacinth-based system permit-time would be longer since the EPA does not have general knowledge of it.

It is anticipated that San Juan will cost approximately \$16,000 to convert to a hyacinth-based system, while Edcouch will cost approximately \$40-45,000, because an additional four (4) acres are required for ponding. The City of Alamo, which would require additional levees, will cost approximately \$35-40,000 for conversion to water hyacinth-based wastewater treatment.

These cost estimates were based on a preliminary review of needs. A more detailed study of the situation would be required to ascertain the complete cost picture.

Mr. Clark also indicated to Caspan Corporation that water hyacinths currently harvested are buried, and that he has not made any significant attempts at utilizing the harvested plants on a profitable basis.

### 3.1.3 Texas Water Quality Board

Mr. Pedro Martinez, Biologist for the Texas Quality Board, ranked the following cities on the basis of need for water hyacinths:

Alamo.....	#1
San Juan.....	#2
Cotulla.....	#3
San Benito.....	#4

#### 3.1.4 Weslaco

The City of Weslaco, being one of the larger cities involved in this survey, has more personnel and facilities to offer a water hyacinth program. In addition, enthusiasm for such a program was high; however, for purposes of this study, it is recommended a smaller community be selected.

#### 3.1.5 Mission

The City of Mission, while having the necessary requirements for the implementation of a water hyacinth-based wastewater treatment program, did not express a very high level of interest in such a program when interviewed by Caspan Corporation.

#### 3.1.6 La Feria

Community support for a water hyacinth-based wastewater treatment site implementation was low when contacted by Caspan Corporation.

### 3.2 Evaluation of Florida Cities as Possible Sites for Water Hyacinth-Based Wastewater Systems

#### 3.2.1 Introduction

For a variety of reasons, Florida cities in general were not responsive to a water hyacinth-based wastewater treatment system when contacted by Caspan Corporation under the parameters of this contract.

Prevailing treatment philosophy does not allow for discharge, while a water hyacinth-based system is founded upon eliminating pollutants from effluent, but not eliminating the effluent itself. In addition, the generally high water table and current Florida DER permit requirements make water hyacinth-based systems undesirable as wastewater treatment alternatives in the southern portion of Florida.

#### 3.2.2 Punta Gorda

Although Community support for a water hyacinth-based wastewater treatment system was rated high, Mr. Robert Hollander, City Manager of Punta Gorda, qualified his support with a

number of parameters, including a very high water table that makes ponding very difficult, and the prevailing "no discharge" wastewater treatment philosophy of the Florida Department of Environmental Regulation.

#### 3.2.3 Clewiston

Community support for a water hyacinth-based wastewater treatment system was rated low or non-existent because the city's treatment plant currently favors land spreading of effluent. In addition, planning to upgrade the system has progressed far enough that alternatives are strictly limited.

#### 3.2.4 Avon Park

Water hyacinth-based treatment systems for this community are not favored because the city's plant borders a lake and this type system was adjudged too dangerous to that body of water for implementation.

#### 3.2.5 Williston

Positive community support for a water hyacinth-based program was expressed by community authorities when contacted by Caspan Corporation. However, this cooled when consideration of such a system by the engineering firm retained to do a "201" study for the city was noted and the recommended one-year length of a water hyacinth program was mentioned.

### 3.3 Recommendations

#### 3.3.1 Florida

Florida sites, when surveyed, were found to be generally unsuitable for implementation of a water hyacinth-based system. Principle factors contributing to this conclusion were regulatory philosophy and the stage of planning to meet permit requirements in most communities.

The Florida Department of Environmental Regulation discourages the use of stabilization ponds and subsequent surface discharge. Instead, the DER recommends land disposal or evaporation/percolation ponds for wastewater disposal. This philosophy is based upon the fact that southern Florida has a very high ground water table and the potential receiving waters for municipal effluent are estuary in nature.

In addition, all the districts of South Florida are heavily involved in the "201" program of the DER. A considerable number of cities contacted were already past the first step in planning activities and in almost all cases water hyacinths had not been considered.

### 3.3.2 Texas

In contrast with Florida, communities in South Texas have been adjudged excellent candidates for implementation of water hyacinth-based wastewater treatment systems by reason of a number of factors unique to Texas, including current treatment systems employed, regulatory philosophy, stage of planning to meet permit requirements, and economic conditions.

Treatment facilities currently used in South Texas are generally stabilization ponds and conversion to water hyacinth systems would be highly feasible. In addition, the Texas Department of Water Resources seems to be open to systems employing water hyacinth treatment, as long as necessary permits can be obtained from the Texas Parks and Wildlife Department.

The agencies responsible for meeting Environmental Protection Agency requirements for effluent quality have done some exploratory investigations into water hyacinths technology and applications; however, none of the communities surveyed had applied for EPA construction grants, although economic conditions at these cities necessitate financial assistance in upgrading current facilities.

Among the Texas facilities surveyed, the site recommended for implementation of a water hyacinth-based treatment system is the tri-city combination of Alamo, Edcouch, and San Juan, all owned and operated by the Lower Rio Grande Valley Pollution Control Authority.

Basic recommended elements of an implementation plan for this tri-city area are as follows:

- 1) A detailed reassessment of the wastewater treatment facilities involved;
- 2) Development of conversion plans for implementation of a hyacinth program;

3.3.2 (continued) .

- .3) Identification and definition of operating parameters, such as degree of water hyacinth cover, harvesting frequency, etc.; and,
- 4) Establishment of appropriate testing programs and schedules.



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